Title:

TE and Field Strength Dependence of Temporal and Spatial S/N in Human and Phantom Single Shot Imaging

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Abstract:

Introduction

Signal to noise ratio, among other things, is a function of voxel size, and field strength. In fMRI we collect time series data, therefore, assessment of temporal S/N has many practical and theoretical implications. Temporal S/N is dependent on many things: system stability, physiologic processes such as breathing, heartbeat, motion, and possible spontaneous susceptibility changes related to blood flow. In this study we compare spatial and temporal S/N between 3 T and 1.5 T at 3 different echo times during rest and rapid breathing.

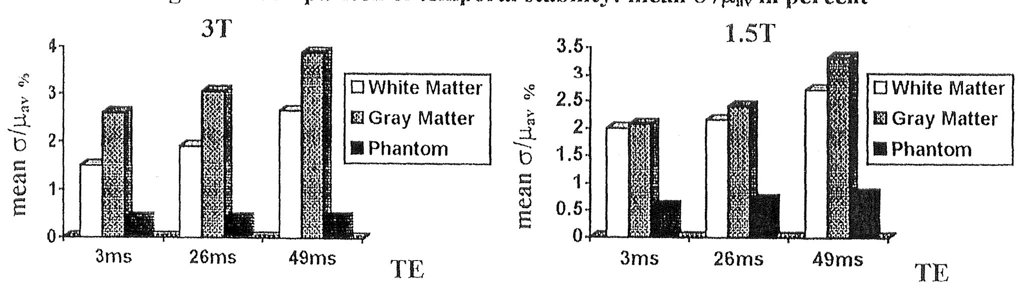
Subjects & Methods

MR data were acquired using a 3 T and a 1.5 T GE scanner with a standard quadrature head coil. A single-shot spiral was used for single slice imaging. 512 images were obtained at 3 echo times -TE: 3ms 26ms, 49ms - for each TR (TR:1s, FOV: 24cm, 64x64, 4mm). Baseline noise measurements were acquired at 0^0 flip angle. Rapid breathing was performed at 2 Hz. Seven phantom and four subject data sets were acquired on both scanners under an approved IRB protocol. Each data set was segregated into 3 subsets corresponding to each echo time. For each voxel in each subset image the average temporal amplitude (μ_{av}) and the temporal standard deviation (σ) of the signal were calculated [1]. The ratio of σ/μ_{av} was obtained as an index of temporal stability and then was averaged over regions of interest corresponding to white and gray matter in the human subjects; a spherical ROI was used for the phantom experiments. Spatial S/N was assessed by μ_{av}/baseline at RF=0^0. Breathing and heart rate effects were assessed by measuring the amplitude of the corresponding peaks from each voxel power spectrum.

Results

In phantoms mean σ/μ_{av} showed no significant increase with TE; 0.4% at 3T and 0.5% at 1.5T. Spatial S/N is approximately 50% higher at 3T as expected. We observe that the subject mean σ/μ_{av} increases exponentially with TE and it is approximately the same for both field strengths. Figure 1 illustrates the results obtained from the TE and field strength comparison. Preliminary spectral measurements during rapid breathing showed a 25-30% increase of breathing and heart rate effects across TE at 3T as compared to 1.5T.

Figure 1: Comparison of temporal stability: mean σ/μ_{av} in percent



Conclusion

The above results support the assumption that even though higher fields provide for better S/N and temporal signal stability, physiologic noise appears to be dominant, therefore counteracting higher field benefits; physiologic noise needs to be filtered out, otherwise one does not gain all the advantages of higher functional contrast and signal to noise. Further S/N measurements at both field strengths are being performed while varying TR, resolution, flip angle, and using EPI, as well as further spectral analysis to examine frequency components.

References

[1] Ye, F.Q. et. al. (1998), ISMRM 6th Scientific Meeting Proc. 2:1210.